5 From Sun to Sunfish

Questions to consider

1. What are some of the basic survival needs of all living things?
2. What is a population? What is a community?
3. What is habitat? Why is it important? Why must organisms compete for resources? What is carrying capacity?
4. What is a niche? Why is it important? What are invasive species? Why are they a problem?
5. What is the source of energy for aquatic communities? How does energy circulate among organisms in an aquatic community?
6. What is a food chain? What is a food web? What is an energy pyramid? What is a trophic level?
7. How do predator and prey species keep one another in balance in aquatic communities? What is natural selection?

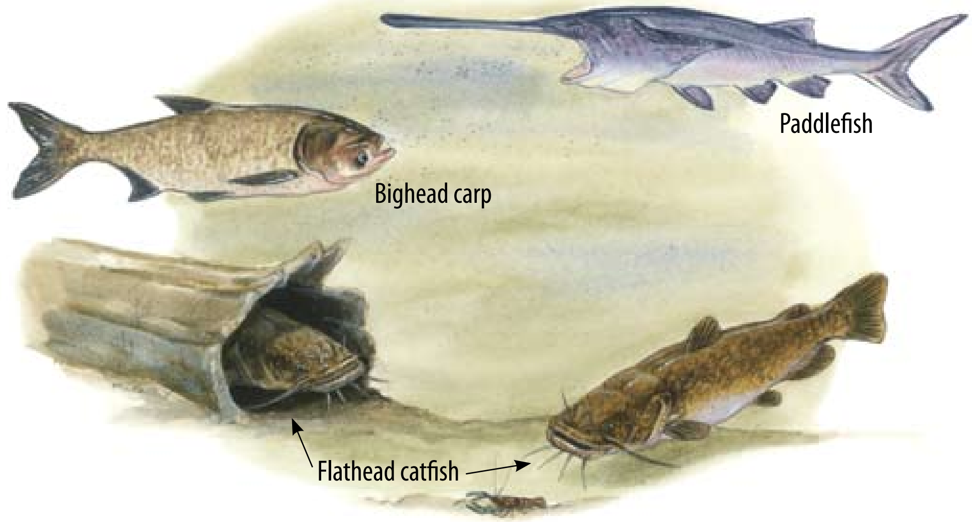
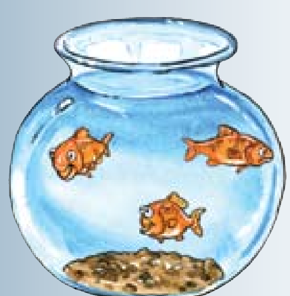


FIG. 5.1—Paddlefish and flathead catfish can both live in the same river because they don't compete for the same niche. Paddlefish eat microscopic **plankton** and spawn in gravel-bottomed tributaries, while flathead catfish hunt and eat small fish and crayfish. They spawn in logs or other sheltered areas on the river bottom. Bighead carp, a recently introduced invasive species, competes with the native paddlefish for plankton.

What do you need to survive? You need air to breathe, water to drink, food to eat and shelter to protect you from the elements. All living things have basic survival needs similar to yours. For organisms to survive, they must be able to meet all of their survival needs. In addition, while it does not influence the survival of individuals, reproduction must occur for a species to continue to exist.

A group of one kind of organism living in the same place at the same time is a **population** of that species. A group of the same kind of algae, a group of the same species of pond snail, or a group of bluegill are all examples of populations you might find living in a pond. Different populations living in the same place interact with one another. A group of populations living in the same place is called a **community**. The algae, snails and bluegill—along with all the other organisms living in or around the pond—interact with each other and make up a pond community.

The physical environment that a species needs to survive is its **habitat**. Habitat is more than a place. Habitat is the shelter a species uses to escape predators and the elements, as well as the space it needs for reproducing and for hunting, gathering or producing food. It includes all the conditions a species prefers. For example, trout need cold water with high dissolved oxygen content in order to survive. Trout can only live in Missouri near springs and even then their ability to reproduce without human intervention is limited. They were brought to Missouri for fishermen and are not well adapted to conditions here. In contrast, catfish are native to Missouri and are well adapted to Missouri's waters. They are able to tolerate the warm water and low oxygen conditions frequently found here. Many aquatic plants and animals have very specific needs.



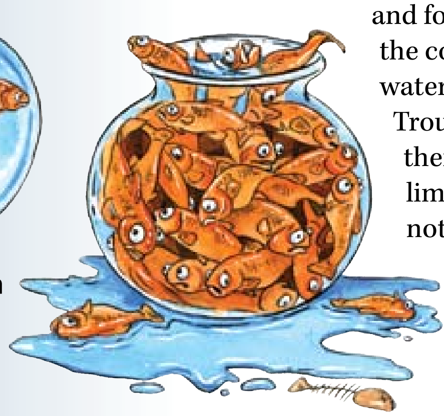


FIG. 5.2—When a population exceeds the carrying capacity of its environment, starvation and disease may result.

They either can't move or can't live in another habitat. Like other resources in an environment, individuals and populations may also **compete** for habitat.

Finding a niche

Within a community every species has a particular **niche**. A species' niche includes its way of getting food, the habitat it needs and the role it performs in the community. Missouri's diverse aquatic environments provide many different niches. For example, paddlefish and flathead catfish both make their homes in Missouri's larger rivers and reservoirs. Paddlefish, however, make their living by grazing on microscopic animals, while flathead catfish hunt and eat small fish and crayfish. These two big-river fish live in the same bodies of water, but they eat different things. They do not compete for the same food. Paddlefish and flathead catfish prefer different places for breeding, too. Flathead catfish seek out nesting sites under rocks and logs, while paddlefish swim upstream to spawn in shallow spots in gravel-bottomed streams. (FIG. 5.1) Different species may have similar or even overlapping habitats, but no two species can occupy exactly the same niche in the same community for long.

Competition and survival

Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. When there is not enough of something to go around, individuals must compete for whatever resource is scarce. Populations within a community may compete against one another as well. Individual bluegills in a pond compete with one another for food. They also compete with green sunfish, since both species feed on the the same prey. When food is scarce, they are negatively impacted by the presence of the other because they will have less food.

The limits on **biotic** (living) and **abiotic** (non-living) resources determine the environment's **carrying capacity**. Carrying capacity is the maximum number of individuals in a particular population that an environment can support. When there are more resources than a particular population can use, the population is below its carrying capacity. When this happens, individuals continue to grow and reproduce. When there are more individuals in a population than the environment can support, the population is above carrying capacity. Populations don't stay above carrying capacity for long. Once a population exceeds its carrying capacity, individuals may starve, get sick or be forced to move to a place that can support them. Some examples of resource limits are the availability of food or habitat. If a population does not have enough food or habitat to sustain itself, it has exceeded its carrying capacity. (FIG. 5.2)

Go solar!

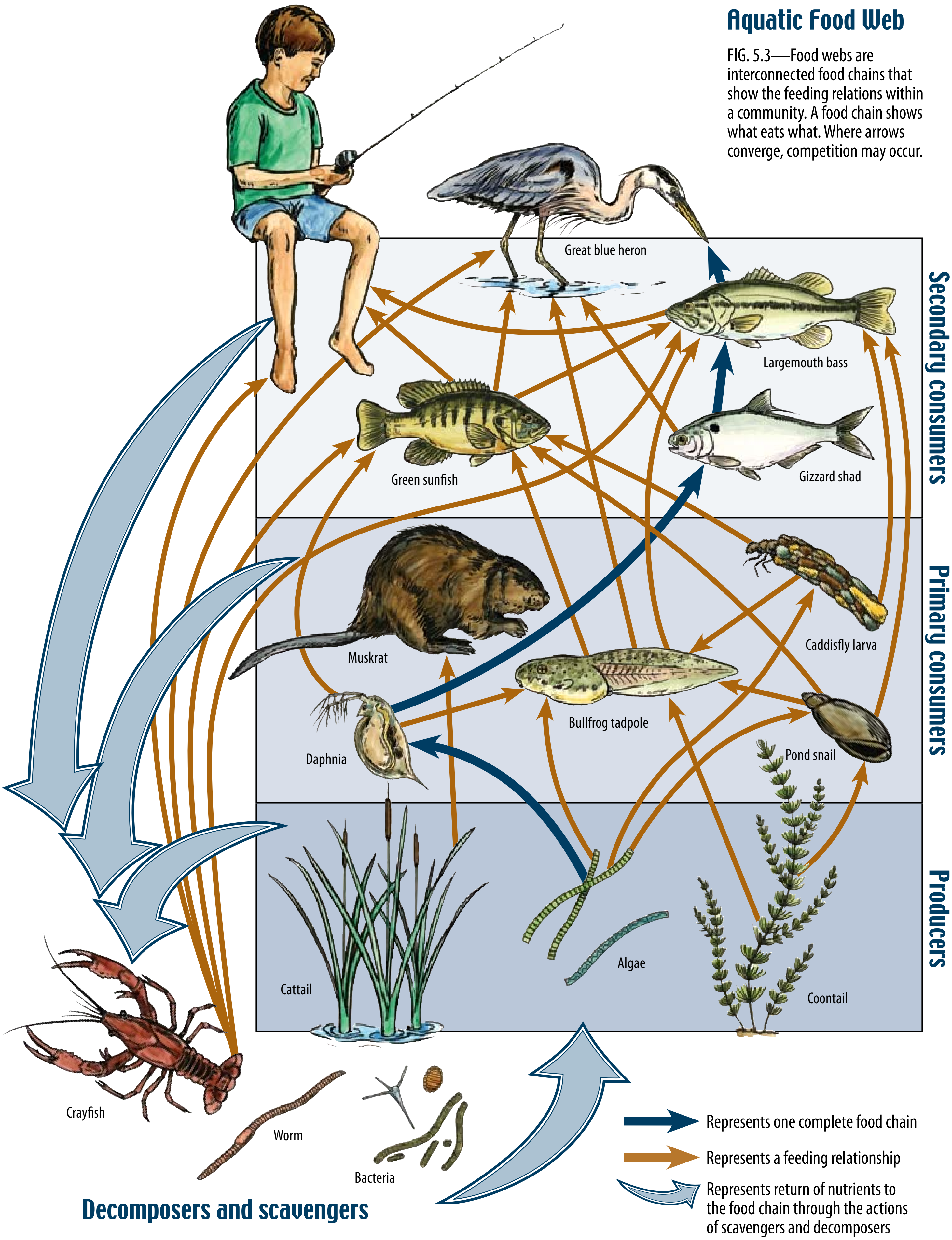
Aquatic communities run on sunlight. Plants capture the sun's energy and use the process of photosynthesis to turn sunlight, carbon dioxide, minerals and water into food and oxygen. Plants are called **producers** because they produce their own food. Unlike plants, animals cannot make their own food. To survive they must eat other living things. Animals that eat plants are called primary **consumers**, or herbivores. A pond snail is a primary consumer because it eats algae and other aquatic plants. Secondary consumers eat primary consumers. Sunfish are secondary consumers—they eat insects, crustaceans, and small fish. Secondary consumers can be carnivores or omnivores. Carnivores kill and eat other animals. Omnivores eat both plants and animals. Parasites such as leeches get their energy directly from feeding off of another living organism, but they usually don't kill the organism in the process. Scavengers such as crayfish eat the organic material of dead plants and animals. **Decomposers** such as bacteria and fungi also feed on non-living organic matter, in the process breaking it down into simple molecules that plants can use. Scavengers and decomposers play a vital role in recycling the energy and materials from the flesh of dead organisms directly back into the system for producers and other consumers to use.

A **food chain** shows how energy moves from producers to primary consumers to secondary consumers and so on. Food chains show what eats what. While they are easy to understand, food chains are simplified versions of what really happens in a community. Most animals have many sources of food, and each food source feeds many different kinds of animals. To illustrate this fact, **food webs** show how different food chains are interconnected. (FIG. 5.3) Taking out any link in a food web may upset the balance of the whole.

An **energy pyramid** is another way to look at feeding relationships. If you divide a pyramid into levels, you can see that the widest one is at the base and the narrowest one is at the top. The pyramid shape not only shows what eats what, but how much energy is available at each consumer level. Consumer levels are also known as **trophic levels**. Only a little of the sun's energy passes from one trophic level to the next. (FIG. 5.4) Animals lose energy doing tasks such as hunting and keeping their bodies warm. An energy pyramid illustrates this lost energy by showing each higher trophic level as a narrower block than the one below it. Most of the available food energy is lost moving up each trophic level. For example, it takes about 3,200 pounds of microscopic plants to produce 410 pounds of microscopic

Aquatic Food Web

FIG. 5.3—Food webs are interconnected food chains that show the feeding relations within a community. A food chain shows what eats what. Where arrows converge, competition may occur.



animals. Those 410 pounds of microscopic animals can feed 58 pounds of crayfish, snails, mussels, clams and aquatic insects. Those animals may in turn be eaten by up to 8 pounds of bluegill. Eating 8 pounds of bluegill will allow a largemouth bass to grow by 1 pound. An environment can support only a certain amount of life at each step of the energy pyramid. The higher up the energy pyramid an animal feeds, the fewer of this kind of animal the environment can support. Most energy pyramids can continue for only four or five trophic levels and can support only a few top-level consumers.

Consumers tend to specialize in the way they get their food. This feeding specialization is part of the animal's niche. Predation is a form of competition. Both predator and prey are competing against one another for survival; the predator is seeking food, and the prey is trying to keep from being eaten. To complicate matters, a species may be both a predator and prey at the same time. Predator/prey relationships develop naturally within a community. These relationships help to balance numbers within a group. Predators play an important role by keeping populations of prey species below their carrying capacity. At the same time, the amount of prey available in a predator's habitat can limit the number of predators that can live there.

For example, catching all the largemouth bass in a pond could lead to an overabundance of sunfish, since bass eat sunfish. With nothing to eat the sunfish and keep them below carrying capacity, they might in time become too numerous. Too many sunfish could eat all the snails and tadpoles in the pond. Without tadpoles to eat the algae, the algae could grow too much. An overgrowth of algae could use up all the available plant nutrients. The overgrown algae might then die all at once. Decomposers such as bacteria would feed on the dead algae. This process could use up all the dissolved oxygen in the water, which ultimately could result in the death of all the fish in the pond!

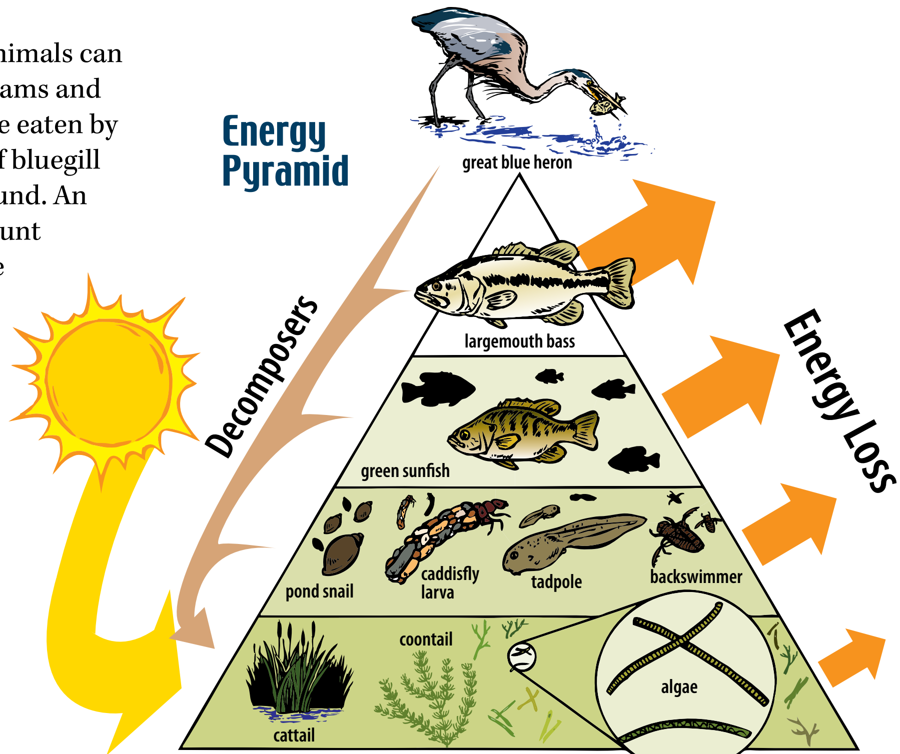


FIG. 5.4—As energy flows through the aquatic community, all organisms capture a portion of that energy and transform it to a form they can use. But this process is inefficient—only a little energy from each level of the energy pyramid is transferred upward. The rest is lost hunting for food, generating body heat or in other life processes.

Competition between members of a species is the driving force of **natural selection**. Natural selection is the process of sorting individuals based on their ability to survive and reproduce in their environment. Natural selection ensures that only the best-adapted species survive and reproduce. It happens as members of a species compete for resources, such as food, water, territory and sunlight. Some varieties of a species "win" because they are the ones best suited for survival in the environment. The tendency for the fittest, healthiest and most adaptable organisms to survive and reproduce helps the population to pass on useful traits and abilities to future generations. As a result, the species changes over time as it adapts to the environment in which it lives. All aquatic plants and animals, including fish, have adapted over millions of years to live in water.

Alien invasion!

Human-caused habitat destruction is the biggest threat to aquatic communities. Another serious threat is **invasive species**. A species is called invasive if it has been brought (usually by human action) to a place where it did not live naturally. If the invasive species can breed and sustain itself in the new habitat, then there is likely to be trouble. The invasive species may compete with native species for habitat or food. This competition could make it harder for the native species to survive. Over time, this invasion can unbalance the community. As a result, native species could become endangered.